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ABSTRACT

There are several problems associated with research using the schema concept. One problem is that there seems to be a lack of cumulative development, with the research being horizontal in quality, spreading out to new areas. Another problem with schema research is that a person not already convinced of the merit of the schema notion can remain unconvinced by the entire body of evidence relating to schema. What appears to be lacking is a formal theory of schemas that not only describes their own nature but also shows how they fit into overall cognitive processing. A theory that gives an adequate account of schemas as structural entities must give an account of processing as well, because in general one cannot test a structural hypothesis without an auxiliary set of assumptions about processing, and vice versa. A theoretical effort at defining schema processing as well as structural issues would have a number of beneficial effects, including the following: (1) schema research would acquire a vertical, cumulative quality: (2) the research might go a long way toward answering the objections of the unconvinced: (3) research efforts could be coordinated: (4) there would be a clear test for what is and what is not part of the schema hypothesis: and (5) negative evidence (failed replications and different findings) could be applied usefully to the advancement of schema theory. (RL)

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Schemas in Memory? Increasing the Usefulness of an Unconfirmable Hypothesis

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In the last several years a great variety of imaginative and carefully done research using the concept of the "schema" has appeared in social psychology. We have seen a number of demonstrations of the organization of memory in schema-like ways in many different areas. But two features of this body of research catch the observer's eye:

1. There seems to be a lack of cumulative development. The research has a horizontal quality--spreading out to new areas--rather than a vertical, cumulative quality. We know how to set our graduate students to do a schema study in a new domain of materials but not how to build on previously existing work.

2. One who is not already convinced of the merit of the schema notion (e.g., an associationist) can remain unconvinced by the entire body of evidence we have amassed. Like Ted Kennedy speaking to the machinists' union, we are communicating only to an audience of the already convinced. One who is motivated to do so can provide alternative accounts of all the schema studies in the literature (though at some point this endeavor becomes ad-hoc-ish).

Why is this? Others have noted that we lack a consistent definition of the term schema in this literature. (Our own observations confirm this: in reviewing the literature we encountered only a single instance of one paper on schemas citing another for its definition. All of the others gave their own definitions in their own words--a sure recipe for confusion.) The term has been used in a fascinating variety of ways, some clearly similar, others bearing a sort of family resemblance, and still others completely inconsistent. The relations of schemas to prototypes, scripts, themes, and other constructs also remain unclear.

In our view, however, the lack of definitional agreement is only a symptom of a problem that actually goes much deeper. What we lack is a formal theory of schemas giving not only their own nature (i.e., a definition) but also showing how they fit into overall cognitive processing. (In fact, we need an unambiguous way to discuss processing. The limitations of verbal formulations for subtle process issues are well known but psychologists have tended to ignore them and concentrate on structural concepts--like the schema.)

A formal theory of schemas does not seem to be close at hand. Even many of its general outlines are unclear. For example, a schema is usually viewed as a chunk (Miller, 1956) of information that is stored together in the file system. However, with a different set of assumptions about cognitive processing, a schema also could be a set of nodes in a flexible associative network that are interlinked such that when one of the set becomes active the others tend to become active as well. The set of nodes is a schema, though not in the usual way we think of it, and it has the desirable property that one node or concept can be part of many sets (schemas). Thus memory can be more or less schema-like in its organization, along a continuum, depending on the relative linked-ness versus independence of the nodes: we need not think of it as either/or.

A theory that gives an adequate account of schemas as structural entities must give an account of processing as well because in general one cannot test a structural hypothesis without an auxiliary set of assumptions about processing (including behavioral output), and vice

versa. A formal proof of this statement can be found in Anderson (1976). With an appropriate set of processing assumptions, for example, a fixed chunk-like memory could give all the same observable results (including reaction time results!) as an associative network memory with its set of processing assumptions. Yet our processing assumptions have generally remained implicit, and what little theoretical effort has been devoted to schemas has centered on structural issues such as the level of abstraction at which schemas exist or the nature of inter-schema connections. (One structural issue notably lacking research or theoretical attention is individual differences in schema content.)

Processing issues have received almost no theoretical attention, and let me list a few question marks: What types of processing take time (i.e., influence reaction times) and how much? What is easy and immediate (retrieval of information by certain types of links, for example) and what takes effortful search? What does the activation or priming of a concept mean, how can it be done, and what are its effects? What happens over time (decay of activation)? How do false-alarm recognitions occur (these have served as definitive tests of schema organization in several studies) and how are they influenced by the contents of memory? How are schemas related to non-verbal (particularly visual) material? A study by Lord (1980) gives some exciting hints here. How do schemas develop? The conventional answer here, given by virtually everybody, is that they are induced from experience. This is clearly inadequate; the origin of most schemas is profoundly social. How do we know that the poor are lazy or that politicians always smile? We are told these things by others or by the media rather than inducing them from our own experience (which may be nonexistent) with the poor or with politicians. (In the same way, Katz & Braly's subjects in the classic 1933 stereotyping study were willing to report character traits of "Wallonians"--not on the basis of their experience.) This profoundly social and cultural aspect of schemas has been slighted by social as well as by cognitive psychologists. Finally, we have the all-important issues of how the contents of memory affect the encoding and processing of new input. Hastie (1978) notes in his review of schema-memory research that there is no good theory even of the central issue of how schema-congruent, -incongruent, and -irrelevant events differ in their processing.

There are a few exceptions: works that have put schema proposals in the context of processing assumptions. I would like to summarize those briefly here since they appear not to be widely cited or known among social psychologists.

Spiro (1977) developed the "state of schema" approach to the issue of text comprehension and memory. The state of schema (SOS) is a subset of the information from a schema, including specific story details, overall impressions, or rules for inference. Over time the SOS from a story changes in predictable ways as general schemas for events become integrated with it. Spiro builds a complex theoretical statement of how the SOS information is represented, the variables influencing its change over time, and its relation to later recall, and he produces evidence in support of his theory.

Norman and Bobrow (1976) present a theoretical statement of schemas with quite a different flavor, using an extended computer analogy. Schemas are autonomous memory units that provide a framework

to guide the analysis of data. They can be activated either by higher-order conceptual structures or by incoming sensory data; schemas continually examine newly arriving data to see if it fits their specifications and become active (performing some processing) if this occurs. One novelty of the Norman and Bobrow theory is their emphasis on how schemas address each other (refer to each other for processing or for information they need) and they have developed a theory of "context dependent descriptions" which they have expanded into an interesting approach to metaphor and related issues (Bobrow & Norman, 1979). The computer analogy forces consideration of the issue of addressing, with obviously fruitful results, while other schema theorists have not considered it at all.

Smith, Adams, and Schorr (1978) present several studies on fact retrieval and an extensive theoretical account of the results. The work is explicitly tied to a particular theory of memory structure and processing (Anderson & Bower, 1972), with which the results are demonstrably inconsistent. The authors expand their own theory of representation for text and of retrieval mechanisms, which is able to account convincingly for the retrieval accuracy effects in their data (but only accounts for latency effects in an ad-hoc way). An alternative theoretical position, Schank & Abelson's (1977) notion of scripts, is also examined in detail for how it might account for the data. In general this paper is a model of careful attention to theoretical derivation of empirical predictions and thoughtful analysis of data.

If a theoretical effort at defining schemas in terms of processing as well as structural issues bore fruit, it would have a number of beneficial effects.

1. The research on schemas might acquire a vertical, cumulative quality rather than its spreading, horizontal nature of the moment.
2. The body of research might go a long way toward answering the objections of the unconvinced.
3. Agreement among researchers on what schemas are and how they work might result in different researchers' efforts being directed toward similar or complementary issues and even being described in the same terms. This would be a boon to our students and even to us.
4. We could know what is, and what is not, a test of the schema hypothesis. Hastie (1978) notes that many published schema "demonstrations" are more in the nature of evidence that is hard for a simple-minded associative theory of memory to deal with rather than conclusive evidence for a specific type of memory organization (schemas).
5. We could know how to use negative evidence. We currently have a fair amount of this, in the form of failed replications of schema studies (e.g., Marell, 1980) and in the form of differing findings (e.g., Hastie & Kumar, 1979 versus Rothbart, Evans, & Fulero, 1979; Snyder & Uranowitz, 1978 versus everybody else). Yet we don't seem to use this negative evidence very well in setting boundaries on the applicability of the schema concept or identifying important moderating variables. We are in the habit of clicking our tongues over Fischhoff's demonstrations that lay people don't use negative evidence much, but we should look to ourselves. What people in general and psychologists in particular need is a rule telling them what to do with

negative evidence, and for us the rule is in the form of a theory.

However, the adoption of a theory is likely to be a difficult process. There are problems of both social organization and social influence involved. In terms of organization, social psychologists and schema researchers are located in hundreds of organizations, scattered across the continent, and with slow and inadequate means of communication. The adoption of a theory is a matter of response to persuasive communication, which would be facilitated by better communications networks as well as by the persuasiveness of the case for a particular theory and the receptiveness of the audience to theoretical innovations. (Researchers' means of communications and social influence have been adequate to causing the plural form "schemas" rather than the Latinate "schemata" to become the more widely used form.)

What would this theory look like? We cannot offer a detailed picture or a first stab at the theory itself or we would not have left the news to the last few minutes of this talk. But we know some things. First, the need for better notations to discuss process issues is clear. The notation may take the form of computer simulation models (e.g., Fox, 1980). These have the advantage of clarity and unambiguousness in that one can run the resulting computer program to see what it does. Our understanding of scripts, for example, is increased by Schank and Abelson's (1977) efforts at programming them. Other notations are also possible, for example production systems (Newell, 1973). But the prevailing modes of either (a) ignoring process assumptions altogether when one is dealing with structural notions like the schema, or (b) discussing processing only in vague verbal terms that are subject to misinterpretation and ambiguity are quite inadequate for major theoretical advances.

Second, a specific direction for sustained theoretical attention is the need to differentiate the schema notion from other proposals regarding the organization of memory. Try this test: when you next read a paper that uses "schema" as an explanatory concept, try replacing that term with "knowledge." E.g. "The reader's schema for the contents of a movie review allows him or her to pick out the important information ... " becomes "The reader's knowledge of the contents of ...". When this substitution yields a sentence that makes as much sense as the original, it is good evidence that the author is not clearly differentiating schemas from other organized forms of knowledge (or perhaps from knowledge in general). Since nobody in psychology today disputes that we have knowledge, and few dispute that it is organized in some fashion, such a rudimentary use of the schema concept permits only minimal theoretical development and weak empirical tests. Yet the schema notion as it has developed in the past several years does contain more specific content than this, and the clear formulation of that content into a theory is what this paper urges--a theory that is demonstrably distinct from such other proposals for memory organization as Rosch's cognitive reference points, Minsky's frames, Schank and Abelson's scripts, and Anderson and Bower's HAM and its successors.

To make a radical suggestion (which we probably won't follow ourselves), it might be best if the term schema was dropped altogether.

Instead, proposals about the organization and processing of knowledge would have to be stated in fuller detail (lacking recourse to the fuzzily conveyed connotations of the term "schema"). Specific areas of disagreement between different proposals could be seen and submitted to empirical tests, instead of the current situation where quite different proposals often go by the same generic name, suppressing recognition of differences.

The central issues involved in schema research are what they have always been in cognitive social psychology as a whole. From a temporal perspective, they are:

From the past, where does a person's knowledge come from? How does it acquire and maintain organization as the amount of stored information grows exponentially?

In the present, how does the organized knowledge influence the encoding, evaluation, and interpretation of new sensory input? How is the input in turn allowed to affect stored knowledge?

And looking toward the future, how does the organization and use of knowledge serve the person's purposes and goals? How is it related to behavior?

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